PHY 444 Quantum Mechanics

Syllabus | *DR. R. L. HERMAN* | FALL 2025

Instructor

DR. R. L. HERMAN

- Office Hours: MWF 9:30-10:30 AM
- Office: Sartarelli Hall 2007J
- Phone: 962-3722
- Email: `hermanr@uncw.edu`

Course Description

Prerequisite: PHY 335 and **corequisite:** MAT 361. Introduction to basic principles of quantum mechanics. Topics include operators, symmetry, orbital and spin angular momentum, perturbation theory, and applications to simple systems.

Course Content

Required Text: Townsend, J. A, *A Modern Approach to Quantum Mechanics,* 2nd Ed., 2012.

Recommended Readings: Susskind, L., *Quantum Mechanics, The Theoretical Minimum,* 2014. Feynman, R. C., *The Feynman Lectures on Physics,* Vol. 3 (Addison-Wesley, Reading, Massachusetts, 1965) and *QED: The Strange Theory of Light and Matter* (Princeton University Press, Princeton, 1988).

This is an introduction to quantum theory at a level higher than what one would first see in Modern Physics. We will not delve into the history as much, but will dig deeper into the theory. The course begins with the quantum mechanics of spin. In the first five chapters of the book the fundamentals of quantum mechanics are introduced. We will explore the algebraic structure of quantum mechanics as applied to simple spin systems and using matrix representations in low dimensional spaces.

In the second half of the course we use position and momentum operators to investigate the 1D Schrodinger Equation for the typical examples of the finite square well, a particle in a box, scattering from potential wells, and the harmonic oscillator. We will then look into system with spherical symmetry, leading to spherical harmonics and the deriving the hydrogenic wave functions. Depending upon the time available, other topics may be covered such as perturbation theory, EPR paradox, or entangled states.

Besides a maturity in physics, you are expected to have exposure to both linear algebra and introductory differential equations. For example, check out Chapters 2-3 in my notes.

Student Learning Outcomes

- Demonstrate knowledge of fundamental concepts in quantum mechanics;
- Solve the Schrodinger equation for some physically important types of 1D potentials;
- Correctly utilize Dirac notation and linear operators when working with quantum mechanical systems;
- Define and apply matrix representations of spin operators
- Apply separation of variables to solve problems in higher dimensions;
- Interpret the wave function and use operators to obtain physical information such as position, momentum and energy;
- Understand the role of uncertainty in quantum physics, and use the commutation relations of operators to determine whether or not two physical properties can be simultaneously measured;
- Relate the matrix formalism to the use of basis states, and solve simple problems in that formalism.

Web Pages/Email

This syllabus as well as a variety of other relevant information for this class is posted on the internet. The website is located at

`http://people.uncw.edu/hermanr/qm/`

You are encouraged to log onto this page often to check the homework assignments, read text material, listen to videos and read about related topics and further examples. You can email me for hints to homework questions, after working on them, or any other concerns with the topics we are covering.

You will need to continually watch for additions, changes, and announcements for the class. So, make it a daily habit to go to the web site and read something different.

Advice for Success

In order to learn the material in this course and earn a good grade, you need to put in some effort. Do not put off assignments or reading. (Yes, *you should plan to read and re-read the text several times.*) If you do not understand something, ask the instructor. Come to office hours, use the email, ask knowledgeable students, or go to the library/internet and find supplementary material. Additional material will be placed at the course website: `http://people.uncw.edu/hermanr/qm/` The instructor can only cover the basics in class. You are not expected to know the material by only listening to the lectures. You need to work problems and think about what you are doing.

Course Requirements

Homework: Homework assignments will be collected on a regular basis and you will be told when the work is due. As doing homework is very important for learning the material in this course, it will count as 30% of your grade. Late homework is subject to a 10% penalty.

Reports: Some interesting and historical topics will not be covered in depth. However, there will be opportunities for research papers into some of these areas. This will make up 10% of the course grade.

Attendance: YOU ARE EXPECTED TO ATTEND ALL OF THE CLASSES! After three excused absences there will be a penalty of 2% for each absence from your total grade.

Exams and Grades: There will be three exams and a final for this course. The exams will cover the material up to the date of the exam. The tentative dates for the exams are below.

Exams	Chapters	Date
Exam I	Ch 1-2	Sept 10
Exam II	Ch 3-5	Oct 1
Exam III	Ch 6-7	Nov 3
Final Exam	Ch 1-7, 9-11	Dec 8, 8:00 AM

Your final grade will be based on the following distribution

Homework	30%	Exams	40%
Paper	10%	Final	20%

and grade scale

90-100	A
80-89.5	B
70-79.5	C
60-69.5	D
0-59.5	F

Plus-minus grading may be used in special cases.

This syllabus is subject to change!

Artificial Intelligence Use Policy

Core Principles

Learning to use AI responsibly is an essential skill. You are encouraged to explore AI tools for brainstorming, idea generation, and research assistance while maintaining academic integrity and developing critical thinking skills.

Permitted Uses

- **Small assignments:** AI may be used for brainstorming, drafting, and iterative improvement
- **Research projects:** AI may assist with literature review, organizing ideas, and refining arguments.
- **All uses:** Must be properly disclosed and attributed.

Requirements and Responsibilities

Attribution: All AI use must be acknowledged at the end of your submission. Include:

- Which AI tool(s) you used and how key prompts generated useful content.
- A brief description of how AI-generated material was incorporated or modified.

Verification: You are responsible for fact-checking all AI outputs. AI systems frequently generate inaccurate information and fake citations. Cross-reference all claims with reliable sources.

Quality Control: Effective AI use requires skillful prompting and critical evaluation. Minimum-effort prompts produce low-quality results that may harm your work.

Prohibited Practices

- Submitting AI-generated work as your own without attribution.
- Using AI-generated citations without verification.
- Relying on AI for factual claims without independent confirmation.

Academic Integrity Failure to properly attribute AI use violates university honor code policies. While AI can enhance your work, it cannot replace your critical thinking, analysis, and original contribution to the assignment.

Academic Honor Code: All members of UNCW's community are expected to follow the academic Honor Code. Please read the UNCW Honor Code carefully (as covered in the UNCW Student Handbook). Academic dishonesty in any form will not be tolerated in this class. Please be especially familiar with UNC-W's position on plagiarism as outlined in the UNCW Student Handbook. Plagiarism is a form of academic dishonesty in which you take someone else's ideas and represent them as your own.

Student Disabilities: UNCW Disability Services supplies information about disability law, documentation procedures and accommodations that can be found at `www.uncw.edu/disability`. To obtain accommodations the student should first contact Disability Services and present their documentation to the coordinator for review and verification.

Campus Respect Compact. UNCW has recently instituted a Respect Compact to affirm our commitment to a civil community, characterized by mutual respect. That Compact will soon be affixed to the wall of each classroom and can be accessed at: `https://uncw.edu/about/know-us/respect-compact`.